



Bureau of Safety and Environmental Enforcement

BSEE Approval Process for HPHT Projects in the Gulf of Mexico

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“To promote safety, protect the environment and conserve resources offshore through vigorous regulatory oversight and enforcement.”

HPHT Projects

BSEE believes that the deployment of high pressure and high temperature (HPHT) equipment is a high risk activity with high consequences for failure. These activities require a higher level of scrutiny to insure that BSEE accomplishes their primary responsibility of protecting people and the environment and to conserve resources on the Outer Continental Shelf.

HPHT Determination

- Code of Federal Regulations
- Maximum Anticipated Surface Pressure
- Flowing Temperature

Code of Federal Regulations

30 CFR 250.804

- Completion of the well requires completion equipment or well control equipment assigned a pressure rating greater than 15,000 psia or a temperature rating greater than 350°F.
- The maximum anticipated surface pressure is greater than 15,000 psia at the wellhead.
- The flowing temperature is 350°F or greater at the wellhead.

Maximum Anticipated Surface Pressure

- Maximum anticipated surface pressure equals the reservoir pressure minus the reservoir fluid column density gradient from the reservoir to the wellhead.

Maximum Anticipated Surface Pressure

- NTL No 2012-N01 Calculating Maximum Anticipated Surface Pressure:

Gas reservoir

- Use pressure-volume-temperature (PVT) laboratory analysis,
- If no PVT data, use specific gravity of 0.6 (reference air=1.0), and determine the gradient based on the maximum reservoir pressure, the wellbore thermal gradient, and the gas compressibility factor.

Maximum Anticipated Surface Pressure

- NTL No 2012-N01 Calculating Maximum Anticipated Surface Pressure:

Oil reservoir

- Use PVT laboratory analysis,
- If no PVT data, use an oil gradient of 0.23 psi/foot.

Flowing Temperatures

- Thorough flowing temperature analysis is required.
- Temperature effects from flow through the well's configuration can generate flowing temperatures in excess of static reservoir temperature.
- Equipment survival must be evaluated for worst case discharge temperatures during each well phase.

Code of Federal Regulations

30 CFR 250.286 to 250.295

- All projects on the OCS using non-conventional production or completion technology will require a Deepwater Operations Plan (DWOP).
- All DWOP approvals will provide conditions of approval to address using technologies that are not addressed in the regulations.

Code of Federal Regulations for HPHT Projects

- 30 CFR 250.804 - Additional requirements for subsurface safety valves and related equipment installed in high pressure high temperature (HPHT) environments:
 - (a)(1) Design Verification Analysis,
 - (a)(2) Design Validation Testing,
 - (a)(3) Analyses, processes, and procedures ensure that the equipment is fit-for-service in the HPHT environment.

Code of Federal Regulations for HPHT Projects

- 30 CFR 250.804 - Additional requirements for subsurface safety valves and related equipment installed in high pressure high temperature (HPHT) environments:
 - (c) related equipment includes wellheads, tubing heads, tubulars, packers, threaded connections, seals, seal assemblies, production trees, chokes, well control equipment, and any other equipment that will be exposed to the HPHT environment.

BSEE ORDER OF OPERATIONS

1. Drilling Application for Permit to Drill (APD)
 - BSEE District Office and District Operations Support (DOS)
 - Casing design, containment / capping stack and blowout intervention
2. HPHT Conceptual Plan
 - BSEE Technical Assessment Section (TAS)
 - TAS to provide specific HPHT guidance in response
 - APD or Application for Permit to Modify (APM) for a HPHT well completion cannot be approved until Conceptual Plan is approved
3. HPHT Well Completion under APD or APM
 - BSEE District Office and District Operations Support
4. HPHT Deepwater Operations Plan
 - TAS project approval required before well can be placed on production
5. HPHT Well Intervention under APM
 - BSEE District Office and District Operations Support

HPHT Conceptual Plan Summary

- The Conceptual Plan provides a proposed plan for the design and construction of the HPHT equipment.
- The Conceptual Plan provides a proposed plan for the design and procedures of the HPHT well completion (HPHT Well Design).
- The Conceptual Plan provides an outline and specific expectations for the independent third party (I3P) review.
- The Conceptual Plan also includes nomination of an I3P to perform the review.

Conceptual Plan for HPHT EQUIPMENT

Your Conceptual Plan should address:

- Equipment and Assembly List and Diagrams,
- Equipment Categorization,
- Basis of Design,
- Hazards & Failure Mode Analysis,
- Material Selection and Qualification,
- Design Verification Analysis,
- Design Validation Testing,
- Load Monitoring if Fatigue Sensitive,
- Equipment Quality Assurance and Inspection Plan.

Conceptual Plan for HPHT EQUIPMENT

Your Conceptual Plan should address:

- Equipment and Assembly List and Diagrams:
 - Item Tracking Number,
 - Item Description,
 - Item Barrier Category.

Conceptual Plan for HPHT EQUIPMENT

Your Conceptual Plan should address:

- Equipment Categorization:
 - Category 1 – Primary barrier for protecting people and the environment,
 - Category 2 – Secondary barrier,
 - Category 3 – Non critical equipment.
- Any equipment rated at greater than 15,000 psia or 350°F and categorized as a primary barrier or as a secondary barrier if designed using alternate analysis methods, requires an I3P review.

Conceptual Plan for HPHT EQUIPMENT

The following equipment will be a Category 1 barrier for the purpose of I3P reporting:

- Wellhead System
- Wellhead Connectors
- Tubing Head
- Tubing Hanger
- Tree
- Production Casing
- Production Liner
- Production Liner Hanger / Packer
- Surface Controlled Subsurface Safety Valve (SCSSV)
- Production Casing and Liner Cement
- Capping Stack
- BOP
- Completion Workover Riser (CWOR)
- Subsea Test Tree
- Production Tubing
- Packers
- Landing Nipples and Tubing Plugs
- BSDV
- Flowline Risers (CVA)
- High integrity pressure protection system (HIPPS)

Conceptual Plan for HPHT EQUIPMENT

The following equipment will be Category 2 barriers for the purpose of I3P reporting:

- Production Choke
- Jumper Connectors
- Manifolds
- Flowline Jumpers
- Flowlines

Conceptual Plan for HPHT EQUIPMENT

Your Conceptual Plan should address:

- Summary of the proposed basis of design:
 - Identify mechanical loads such as internal pressure, external pressure, tension, compression, bending, internal temperature, external temperature, cyclic loading, etc.
 - Identify environmental exposure such as H₂S, CO₂, Cl, Hg, cathodic protection, etc.

Conceptual Plan for HPHT EQUIPMENT

Your Conceptual Plan should address:

- Hazard identification/hazard and operability study (HAZID/HAZOP) and/or failure modes and effects analysis/failure mode, effects and criticality analysis (FMEA/FMECA):
 - All potential modes of failure must be identified,
 - All potential load cases must be identified,
 - Consequences of failure must be understood.
- Material selection and qualification
 - Material properties needed for design analysis to address identified failure modes,
 - Material tests to be conducted for material characterization.

Conceptual Plan for HPHT EQUIPMENT

Your Conceptual Plan should address:

- Proposed design verification analysis to be conducted for each component and assembly such as strength and fatigue analysis.
- Proposed design validation tests such as prototype tests, initial pressure test, nondestructive examination, destructive examination, life cycle test, etc.

Conceptual Plan for HPHT EQUIPMENT

Your Conceptual Plan should address:

- Summary of the proposed load monitoring for components where fatigue has been identified as a potential mode of failure.
- Summary of the equipment's
 - Fabrication processes,
 - Plan to use a quality management system,
 - Inspection and test plan.

Conceptual Plan for HPHT WELL DESIGN

Your Conceptual Plan should include plans for:

- Typical well schematic,
- Well control, completion, intervention procedures and equipment,
- Tubing and casing force analysis,
- Cementing materials and procedures,
- Packer qualification,
- Threaded connection qualifications,
- Plans for trapped annular pressure management,
- Relief wells and HPHT capping stack,
- Maximum anticipated surface pressure,
- Environmental conditions and material requirements.

Conceptual Plan for HPHT WELL DESIGN

Your Conceptual Plan should address:

- In addition to the well completion components and tubulars, HPHT well completion requires that the following equipment be built and readily available in the GoM:
 - Well control equipment – BOPs, riser, choke Lines, kill lines, and a rated well capping stack,
 - Well completion and intervention equipment – completion workover riser package, subsea test tree, riser system, running tools,
 - Coiled tubing BOP equipment, wireline equipment, tubing plugs,
 - Kill pumps and manifolds,
- Well completion procedures, well control procedures, and well intervention procedures for more than one method of well Intervention (with and without the tree in place).

Conceptual Plan for HPHT WELL DESIGN

Your Conceptual Plan should address:

- Analysis of the production tubing, production casing and production liner for the site specific well for tri-axial forces, burst, collapse, compression, and tension for all possible load cases,
- Analysis of the cementing materials and procedures for the production casing and production liner,
- Packer and bridge plug analysis and qualification,
- Qualification of casing and tubing threaded connections,
- Trapped annular pressure and production casing pressure monitoring and management.

Conceptual Plan for HPHT WELL DESIGN

Your Conceptual Plan should address:

- Relief well capabilities and HPHT capping stack: 30 CFR 250.462(c) “What are the source control and containment, and collocated equipment requirements?” The “Containment Plan Report” describes the source control and containment capacity to the Regional Supervisor,
- Justification for the gradients and calculations used for the estimated MASP and SITP,
- A discussion of the environmental conditions and material requirements to meet the basis of design.

Conceptual Plan for HPHT

Your Conceptual Plan should address:

- Plans for I3P review of the HPHT Equipment and the HPHT Well Design.
- Proposed I3P nomination including:
 - Qualifications,
 - Technical capabilities,
 - Previous experience.

I3P Review

- **Why does BSEE request I3P reviews?**
 - Whenever a new technology application is deemed technically complex and requires a high degree of specialized knowledge, BSEE may seek an I3P review to facilitate the approval process.

I3P Responsibility

An I3P may not be involved directly in the project.

The I3P is responsible for two things:

1. Reviewing the various engineering analysis performed by the operator or the equipment manufacturer and verifying the outcome of the analysis,
2. Capturing the results of their review into a report that is clear, concise and complete. This will become a permanent BSEE record and an integral part of the approval process.

I3P Reports

- Clear: BSEE would like to see a consistent format for I3P reporting.
- Concise: BSEE is asking the I3P to reduce the original engineering analysis by the operator or the manufacturer.

I3P Reports

- Complete: Anyone should be able to read the report and understand what component was reviewed, what the variables were, loads and factors in the review, what analysis methods were used, what standards were used, what test were performed, and what the results of the review were, without having to link the report to any other document .
- The report should contain quantitative information not just qualitative statements of acceptability without stating the factors being considered and the end results of the analysis.

I3P Reports

- Documents that were reviewed during the I3P review must be referenced but not attached to the report.
- Provide a detailed list of all documents and test records reviewed, including author, document name/title, revision number, author's or operator's document number, and a summary of the document.
- Log of I3P questions / responses as they review documents from the operator or the manufacturer. These questions are generally where clarification is needed and these questions are held open until the issue is clarified or resolved.

I3P Reports for HPHT Equipment

- 1). **I3P Report (1A)** Basis of design and functional specifications (requirements)
The report must also include hazard and failure analysis including HAZID/HAZOP and/or FMEA/FMECA for the loads and environment identified in the basis of design
- 2). **I3P Report (1B)** Material selection, qualification, and testing,
- 3). **I3P Report (1C)** Design Verification Analysis,
- 4). **I3P Report (1D)** Design Validation Test. The report should include a summary of tests and test results,
- 5). **I3P Report (1E)** Load Monitoring (required if fatigue is a potential failure mode).
Provide a detailed description of how loads on fatigue sensitive equipment will be monitored,
- 6). **I3P Report (1F)** Fabrication, quality management system, and inspection and test plan that identifies the quality control/quality assurance process, and inspections of the final products,
- 7). **I3P Report (1G)** Final report that ties reports 1A through 1F together.

I3P Reports for HPHT Well Design

- 1). **I3P Report (2A)** Completion, intervention, and kill procedures.
The report must identify all the necessary equipment to do this work and verify the equipment is readily available and accessible and will remain so for the life of the well,
- 2). **I3P Report (2B)** Force analysis for the production tubing, production casing, and production liner for each possible load case identified,
- 3). **I3P Report (2C)** Design verification and validation analysis for cementing materials used in the production casing and liner and associated cementing procedures,
- 4). **I3P Report (2D)** Packer qualification analysis,
- 5). **I3P Report (2E)** Qualification analysis for threaded connections for the production tubing, production casing, and production liner.
- 6). **I3P Report (2F)** Trapped annular pressure and production casing pressure management plans,
- 7). **I3P Report (2G)** Relief well capacity and HPHT capping stack analysis,
- 8). **I3P Report (2H)** Justification for the estimated MASP and SITP,
- 9). **I3P Report (2I)** Discussion of environmental conditions and material requirements,
- 10). **I3P Report (2J)** Final report that ties reports 2A through 2I together.

I3P Reports

- The format is to include:
 - Transmittal letter,
 - Title page,
 - Executive summary,
 - Table of contents,
 - List of figures and tables,
 - Report body,
 - Conclusion,
 - References,
 - Log of I3P request for additional information resolution.

Conceptual Plan Approval

- The final Conceptual Plan is not approved until all the I3P reports are received, reviewed and accepted by BSEE.
- No HPHT well may be completed until the Conceptual Plan is approved.

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